United States Patent [19]

Angelini

[11] **3,852,170**

[45] **Dec. 3, 1974**

[54] **METHOD AND APPARATUS FOR CARRYING OUT CONTINUOUS THICK CHROME PLATING OF BAR, WIRE AND TUBE, BOTH EXTERNALLY AND INTERNALLY**

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[21] Appl. No.: **329,220**

[30] **Foreign Application Priority Data**

Feb. 8, 1972 Italy..... 20337-A/72

Related U.S. Application Data

[63] Continuation-in-part of Ser. Nos. 89,428, Nov. 13, 1970, Pat. No. 375,344, and Ser. No. 261,419, June 9, 1972, abandoned.

[52] **U.S. Cl.**..... **204/28,** 204/207, 204/210

[51] **Int. Cl.** **C23b 5/58,** B01k 3/00, C23b 5/68

[58] **Field of Search** 204/210, 25, 27, 28, 206, 204/209

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Primary Examiner—T. M. Tufariello

Attorney, Agent, or Firm—Fidelman, Wolffe, Leitner & Hiney

[57] **ABSTRACT**

A method and apparatus for bar electroplating including continuously supplying a plurality of bars successively; cleaning the surface of the bars to be plated; heating the bars up to a plating temperature and accomplishing the bar plating operation by feeding the bars along a straight path through an electrode immersed in an electroplating tank.

21 Claims, 22 Drawing Figures

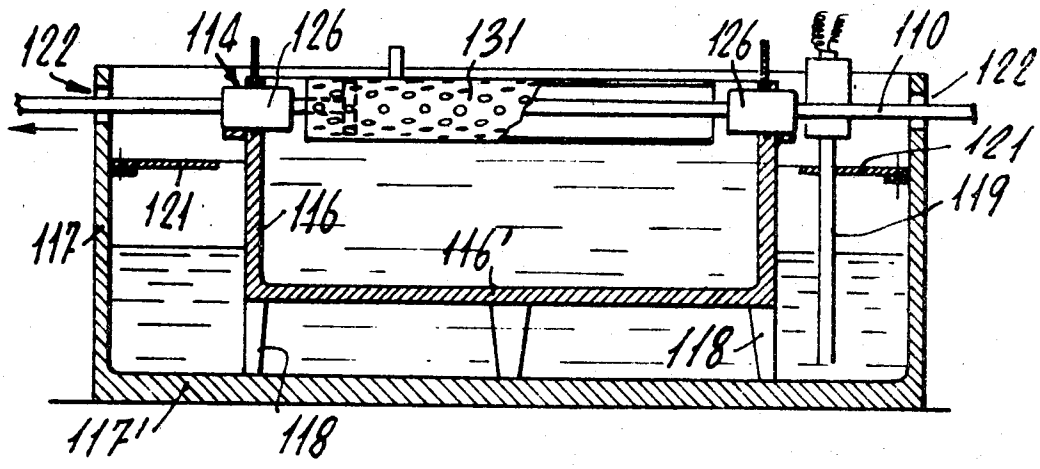


FIG. 1

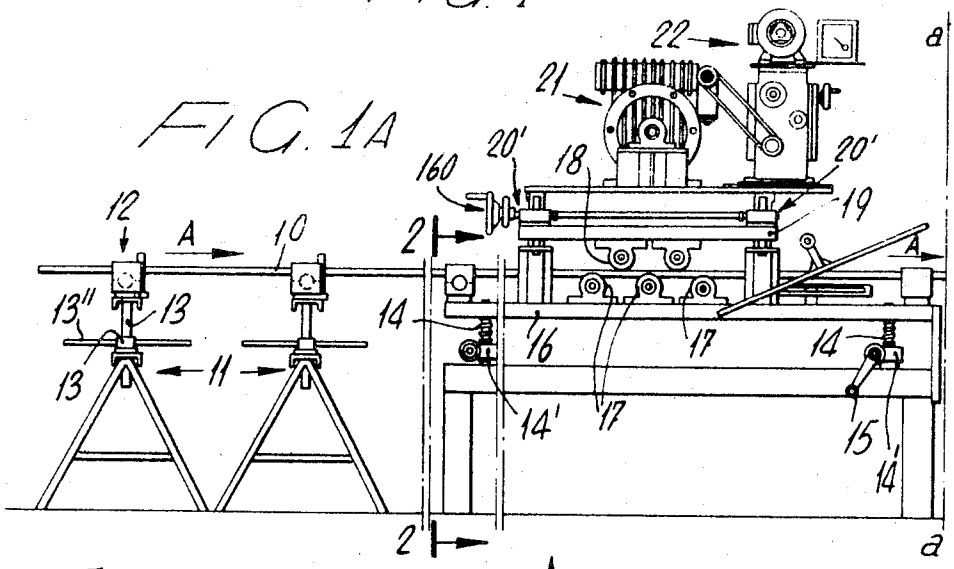


FIG. 1A

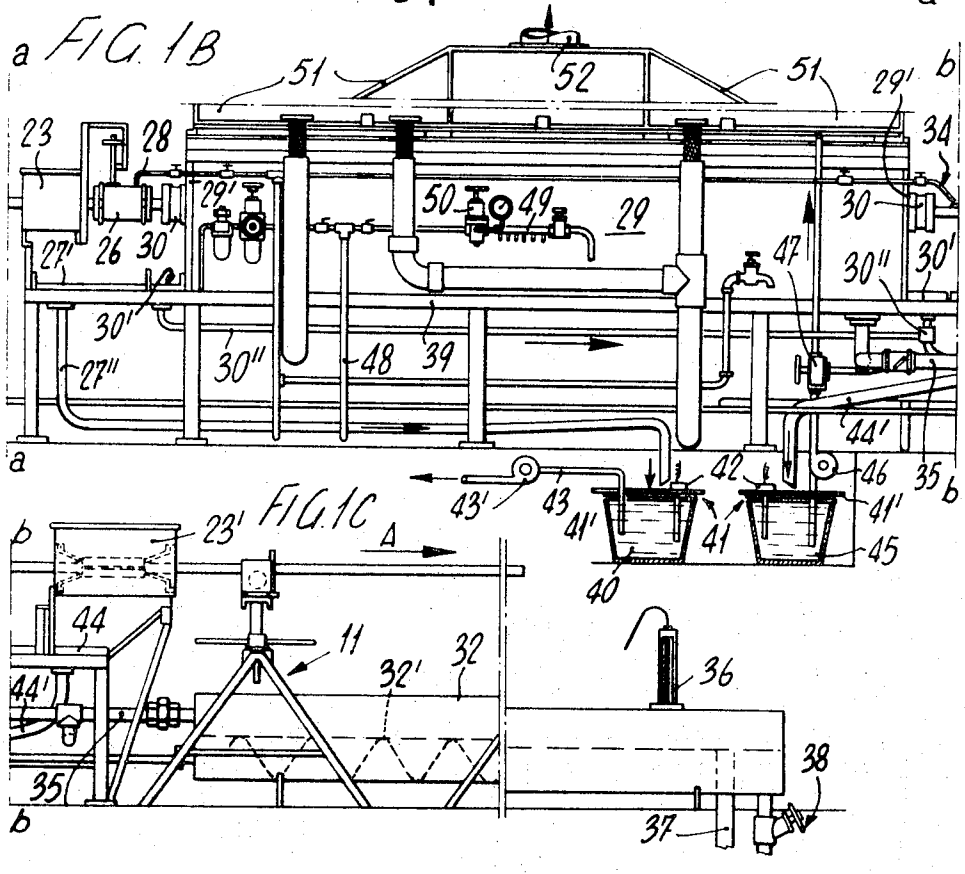


FIG. 1B

FIG. 1C

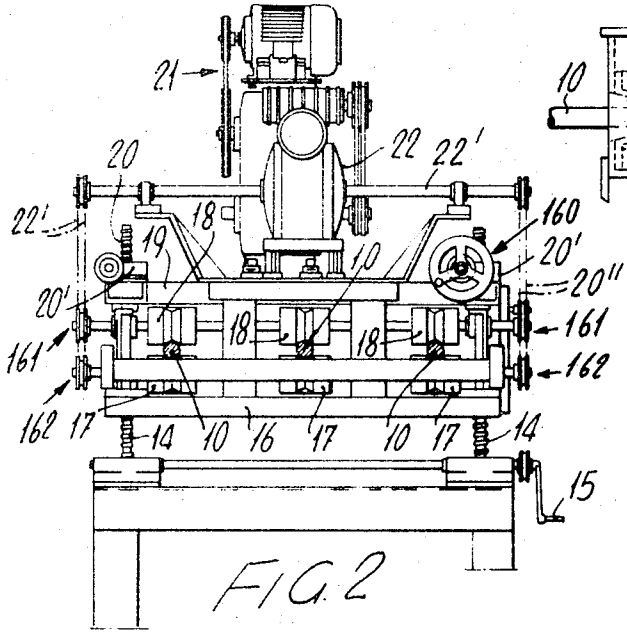


FIG. 2

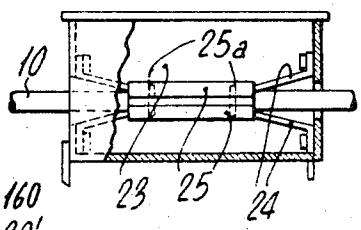


FIG. 4

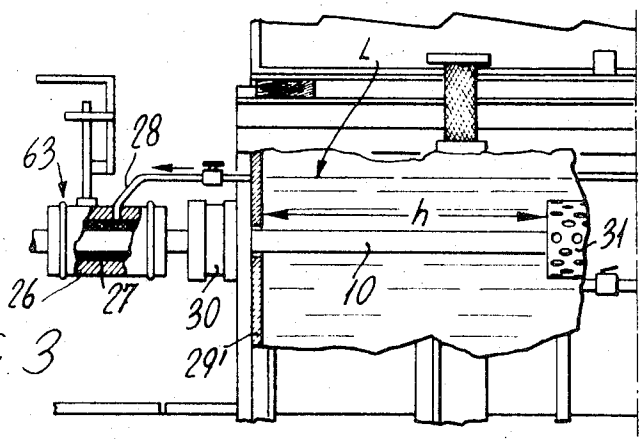


FIG. 3

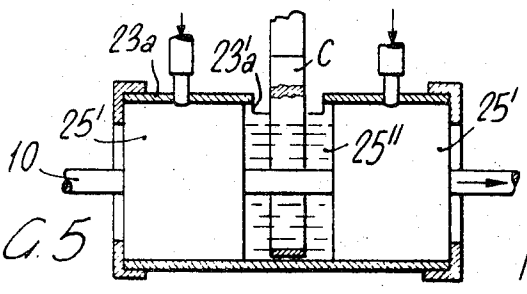


FIG. 5

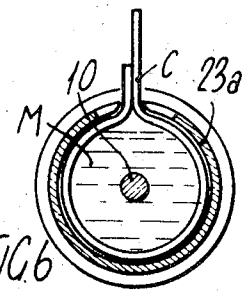


FIG. 6

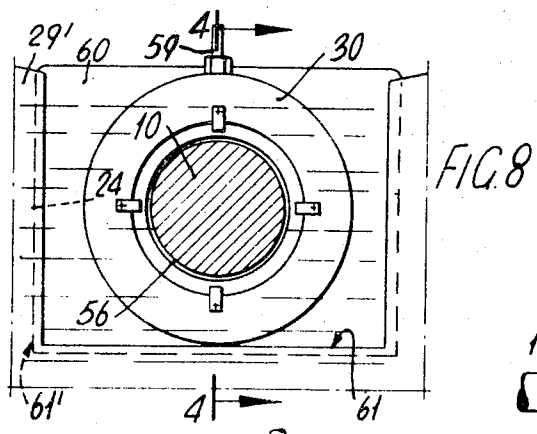


FIG.8

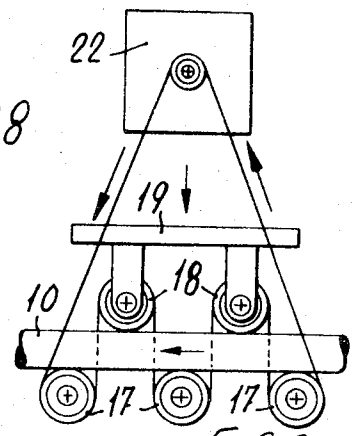


FIG.9

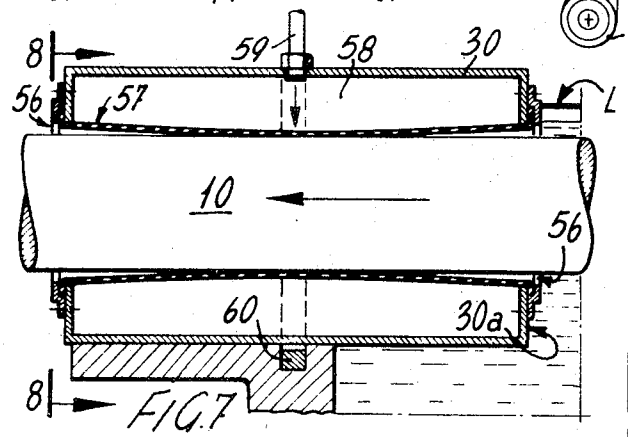


FIG.7

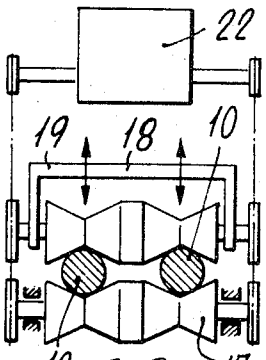


FIG.10

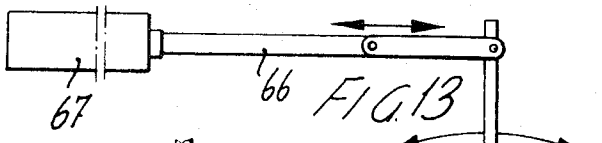


FIG.13

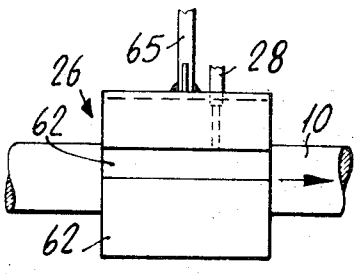
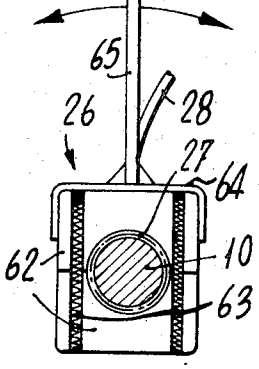


FIG.12



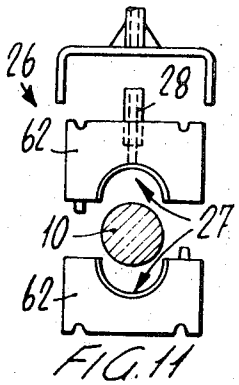


FIG.11

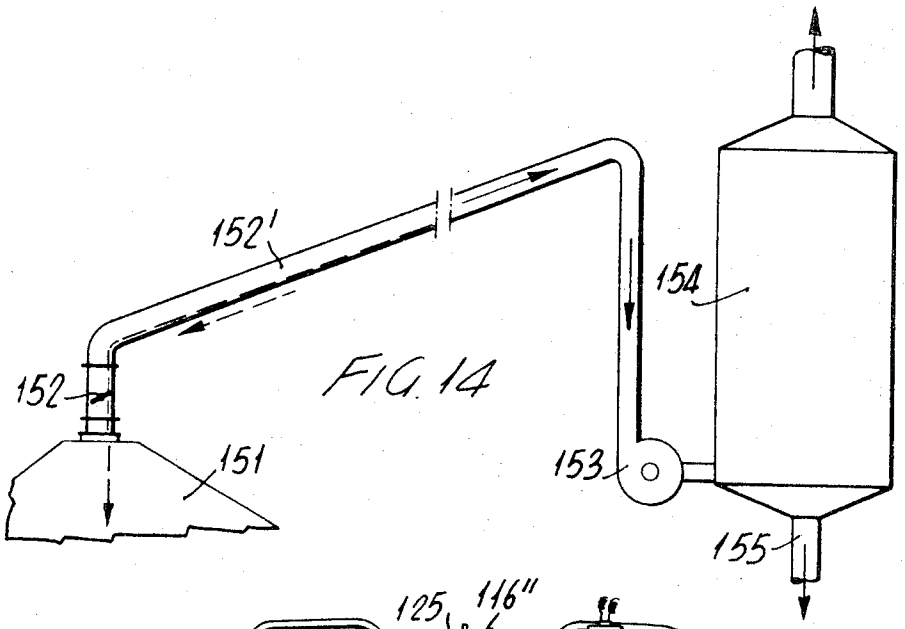


FIG. 14

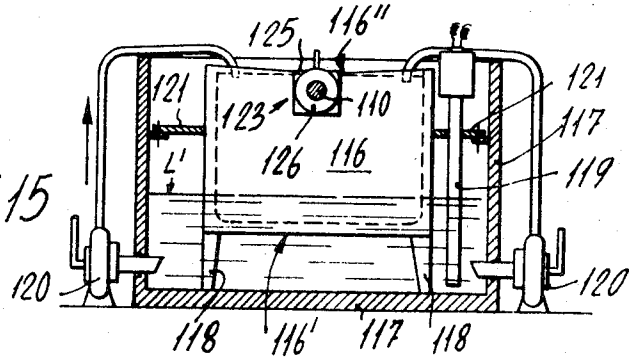


FIG. 15

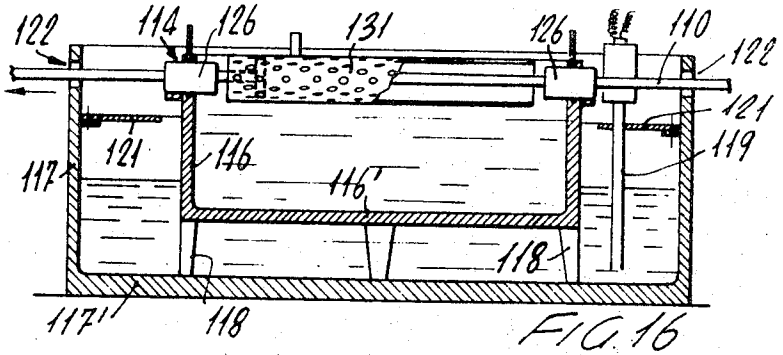


FIG. 16

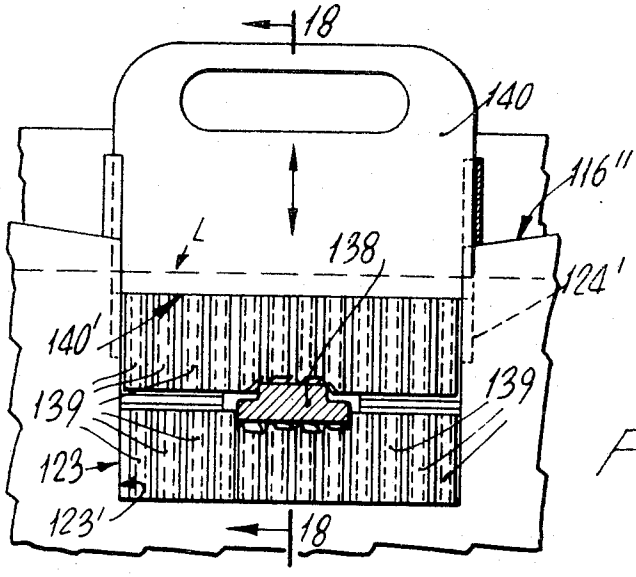


FIG. 17

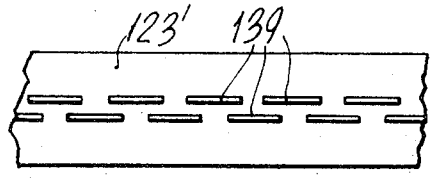


FIG. 20

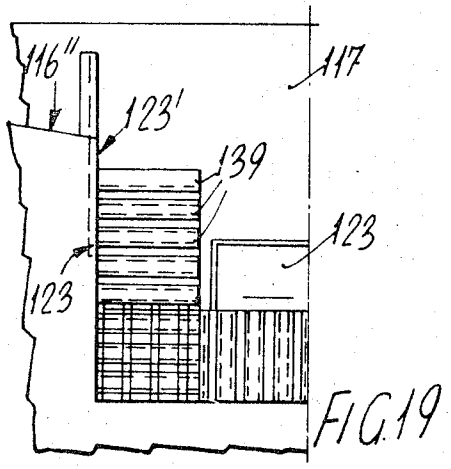


FIG. 19

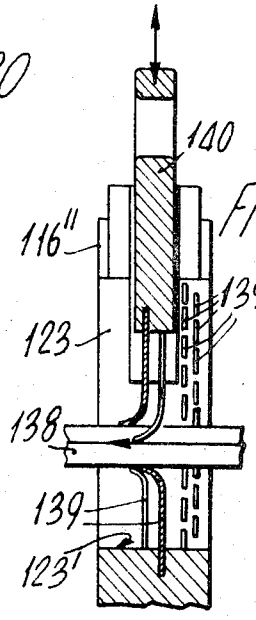


FIG. 18

METHOD AND APPARATUS FOR CARRYING OUT CONTINUOUS THICK CHROME PLATING OF BAR, WIRE AND TUBE, BOTH EXTERNALLY AND INTERNALLY

The present invention is a continuation-in-part of application Ser. No. 89,428, filed Nov. 13, 1970, and now U.S. Pat. No. 3,751,344, and application Ser. No. 261,419, filed June 9, 1972 now abandoned.

This invention relates to a method and apparatus for electroplating, coating or metalization of general bars. More particularly, the present invention relates to chrome plating bars of circular cross-section as well as those that are of different cross-section.

The invention will be hereinafter set forth and described with reference to a method and apparatus for metal bar chromium plating. It should be understood, however, that the invention is not limited thereto and can be extended and used to provide a metal coating on bars by an electrolytical deposition process.

As is well known, in present bar chromium plating systems, provision is made for a tank containing a chromium plating bath. The tank is longer than the bars and the bars are immersed in the bath for a predetermined time period. These systems are extremely cumbersome and expensive due to their size requirements for the tanks. Moreover, the chromium plating is accomplished in a batch method with the resulting low hourly output of chromium plated bars.

Further disadvantages arise due to scrap produced by an inability to chromium plate the portion of the bar gripped and clamped by the lifting apparatus required for immersion of the bars in the tank. Further, due to the deflection of said bars caused by the weight thereof, the distance between the electrodes and bars varies and non-uniform deposition of the chromium coating or plating occurs. The thickness is not uniform or constant longitudinally, increases from the center to the ends and varies circumferentially in accordance with the arrangement of the electrodes within the chromium plating bath.

Therefore, an object of the present invention is to provide a method and apparatus for bar electroplating, and particularly chromium plating for bars and the like, capable of overcoming the above mentioned disadvantages.

More particularly, the invention relates to a method and apparatus for continuously electroplating bars and the like.

Generally, the method according to the invention includes the steps of continuously supplying a plurality of bars consecutively to an electroplating bath; cleaning the surface of the bars to be plated; heating the bars up to a plating temperature and electroplating by feeding the bars along a straight path through an electrode immersed in an electroplating bath.

Particularly, a first preheating step for each bar can be carried out upstream of the plating bath by utilizing the plating current. Then a next heating step can be carried out within the plating bath prior to the plating step by heat transfer from the bath. The bars thus enter the plating electrode at a temperature substantially corresponding to that of said plating bath.

More particularly, the present invention relates to a method for chromium plating either cylindrical or non-cylindrical section bars, wherein the bars are continuously supplied to a chromium plating bath in two or more straight paths parallel to and spaced apart from one another, so as to substantially increase the hourly output of the bath.

A further object of the present invention is to provide a method and apparatus for bar electroplating, and particularly for bar chromium plating, wherein the spacing between the bar to be chromium plated and the anode in the chromium plating bath is maintained constant so as to substantially improve the metal coating deposition on the bars by controlling coating thickness to very close tolerances. Thus, subsequent grinding of the electroplated or chromium plated bars conventionally can be avoided.

The invention is also directed to a general plating system, and particularly to a chromium plating system for bars and the like, wherein the floor space required is minimized in that the chromium plating tank length is substantially less than that of the bars to be processed and wherein, by suitable expedients, tube or non-cylindrical section bars of different diameters can be processed. This is afforded by using special seals at the passage openings for the bars in the tank of the chromium plating system.

Generally, according to the invention, the apparatus for continuous electroplating (and particularly chromium plating), comprises (1) a plating bath having end walls and containing an electrolyte forming the processing liquid; (2) at least one circular plating electrode in said tank and immersed in said processing liquid; (3) passage openings for the bars in said end walls of the tanks and aligned with the electrode along a common axis; (4) sealing means for the moving bars at each of the passage openings in the tank to resist, and preferably prevent, any egress of processing liquid whereby a constant liquid level is maintained; (5) means for supporting, guiding and successively feeding the bars through said electroplating bath or tank along said axis; (6) means for causing a current to flow between said electrode and the bars to be plated; (7) means for cleaning and heating the bars to a plating temperature upstream of the electrode in said tank; and (8) means for feeding and recycling the processing liquid between the electroplating tank and a supply reservoir while maintaining it at a constant temperature.

By adjusting and maintaining the processing liquid at a constant temperature and by heating the bars prior to entering the plating electrode, a smooth and constant plating operation is promoted, thereby providing bars having substantially constant characteristics of the coating layer produced along each of the bars and on different bars.

The system is also provided with means for recirculating the washing water, as well as the processing liquid, for the bars at the tank outlet. A means is also provided for purifying the fumes or vapors from the processing bath.

These and other features of the method and system according to the invention will become more apparent from the following description when taken in conjunction with the attached drawings, in which:

FIG. 1 is a general view of a system according to the invention which, due to drawing requirements, has been divided into three portions joining at the division lines *a—a* and *b—b*, the three portions being indicated as 1A, 1B and 1C;

FIG. 2 is a view taken along line 2—2 of FIG. 1;

FIG. 3 is a partial sectional view showing, on an enlarged scale, a detail of the electroplating tank on the entry side for the bars;

FIG. 4 is a longitudinal sectional view of a box for the electrode contact to the bars to be processed;

FIGS. 5 and 6 are longitudinal and cross-sectional views, respectively, showing a second embodiment of a box for the electric contact to the bars;

FIG. 7 is a longitudinal sectional view of a pneumatic sealing device located at a passage opening for the bars in the processing tank.

FIG. 8 is a view taken along lin 8—8 of FIG. 7;

FIG. 9 is a side view showing a bar drawing device;

FIG. 10 is a front view of the device shown in FIG. 9;

FIGS. 11, 12 and 13 are exploded, side and front views, respectively, of a bar cleaning device for cylindrical bars;

FIG. 14 is a diagram of the device used for removal of the fumes and vapors from the electroplating bath;

FIGS. 15 and 16 are fragmentary cross-sectional and longitudinal views, respectively, of a modified system according to the invention;

FIG. 17 is a front view showing a particular sealing for non-circular section bar electroplating;

FIG. 18 is a vertical sectional view taken along line 18—18 of FIG. 17; and

FIGS. 19 and 20 are different views for a detail of the sealing device shown in FIG. 17.

Referring now to FIGS. 1–3 of the accompanying drawings, it will be seen that a continuous electroplating system according to the invention, particularly for bar chromium plating, comprises a tank designated as a whole at 29 which contains a processing liquid forming the electroplating bath. The metal bars 10 which are to be plated are continuously passed through this tank and are successively mechanically and/or electrically interconnected and fed along one or more straight paths parallel to, and spaced apart from, one another by means of a suitable drawing device, such paths lying on a horizontal plate as shown in FIG. 2.

More particularly, in the course of their feeding, these bars 10 are carried at both ends of the electroplating tank 29 by stands 11 at the top having a support or bracket 12 being carried at the upper end of a vertical screw 13 which rotates in a nut screw 13', operable by handle bars 13'' to adjust the correct height position of support 12 for maintaining said bars 10 at accurate rectilinear attitude.

The bars are connected together in accord with Pat. No. 3,751,344, by means of e.g. threaded or friction fittings. The fittings may be conductive or non-conductive depending on considerations such as bar length, etc. Also, the bars may be of circular cross-section, triangular cross-section, rectangular cross-section or other cross-section, however irregular in shape. Different seal means as disclosed herein may be required for differing cross-sectional bars.

The drawing or feeding of bars 10 to the processing tank 29 is accomplished by a drawing device which, in the example shown in FIG. 1, is located upstream of the processing tank 29 as shown by the bar movement direction according to arrow A, but which could also be downstream of said tank.

The bar drawing device substantially comprises a first frame 16, adjustable in height and carrying the lower drawing rollers 17. Further, upper drawing rollers 18 are supported on a second frame 19 adjustable in height relative to first frame 16. Thus, correct positioning and smooth drawing of the bars can be accommodated independently of the diameter thereof.

For height adjustment of the first frame 16 carrying the drawing device, from FIGS. 1 and 2 it can be seen that vertical screws 14 are provided as rotatably carried by frame 16 and meshing with corresponding nut screws 14' rotated in pairs by corresponding worms operable by a crank.

Similarly, frame 19 is adjustable in height relative to frame 16 by screws 20 secured to said frame 16 and meshing with corresponding nut screws 20' (FIG. 2), rotatably carried by frame 19 and rotatably driven by suitable worms or the like operated by cranks 160.

The above mentioned lower and upper drawing rollers 17 and 18, respectively, are rotatably driven by a geared motor unit 21, carried by frame 19, through a speed variator 22, of which drive shaft 22' carries at its ends pulleys or gear wheels driving, through belts or chains 22, the pulleys or gear wheels 161 and 162 of the bearing shafts of said drawing rollers 17 and 18. Thus, the drawing speed can be varied and adjusted in accordance with the diameter of the bars to be processed and the thickness of the material to be formed on the bars.

As shown in FIG. 2, drawing rollers 17 and 18 are coated with a layer of relatively resilient material, have a circumferential groove formed therein for bar guiding, and are aligned with the feeding axis of the bars. This groove should be slightly distorted when in contact with the bar to increase the friction surface, thus avoiding slippage and allowing for accommodation of bars of different diameters.

The bar drawing device could be adapted for drawing one or more bars, such as parallel bars 10 shown in FIG. 2, or plural bars at one roller as schematically shown in FIGS. 9 and 10, where the drawing rollers 17 and 18 have been made with conical surfaces converging to the center in order to increase the bar adhering surface.

The bars, continuously fed to the processing bath in tank 29, first pass through box 23 wherein electric contacts are arranged for connecting the bars to the negative pole of a D.C. power supply. Thus, the bar portion between anode electrode 31 (FIG. 3) and the electrode 131 (FIG. 16) is charged with the required current flow for the deposition of material, such as chromium, on bar 10. A similar contact box 23' may be provided at the outlet or downstream of tank 29, as shown in FIG. 1.

The plating current flowing through the section of bar 10 between the upstream contact box 23 and the anode 31 is preheated by the current to a temperature determined by the electric resistance of the bar path and the square of the intensity of current flowing through the bar.

It is important to provide a positive electric contact surface with the bars while interferring with the feeding thereof to the least extent possible. This has been accomplished by the contact box of FIG. 4 wherein the electric contact with bars 10 is provided by copper plaits 24 arranged about the peripheral surface of the bar 10. The plaits 24 are clamped against bar 10 by two

opposing tile-like elements **25**, the latter being held in proximity to each other by resilient rings **25***a* or other suitable means and being of a predetermined internal shape corresponding to the number of plaits **24** and the bar diameter.

Downstream of contact box **23**, the bars **10** pass through a cleaning device **26** which comprises a sleeve containing an abrasive material mat or felt **27** (as shown in the cut-away portion of FIG. **3**) completely surrounding bar **10**. The material **27** cleans bar **10** by, e.g., rubbing.

In order to remove any possible impurities from said cleaning device and bar, the sleeve is supplied with hot water at a predetermined pressure through a conduit **28**. The water continuously removes deposits from the bar surface or from the cleaning felt. The use of hot water for cleaning devide **26** is advantageous since it helps retain bar **10** at its preheated temperature as mentioned above. Therefore, in order to collect water dripping from cleaning device **26** or from a plurality of such cleaning devices where the bars are fed along two or more parallel paths as shown in FIG. **2**, a tank **27'** is provided underneath the cleaning device or devices **26** as shown in FIG. **1B**. This tank **27'** collects the water coming out of cleaning device **26** and conveys it through a pipe **27''** to a collection tank **40** which is provided with a net cover **41** at the top thereof for carrying a filter **41'**, so that impurities are retained on filter **41'** and conditioned water enters said tank **40**. The water is withdrawn from tank **40** through pipe **43** and recycled by pump **43'**.

As stated, bars **10** pass through the tank **29** containing the plating bath. Therefore, passage openings for bars **10** provided on the opposite walls **29'** of the processing tank **29** are fitted with suitable sealing devices **30** to resist, and possibly inhibit, any exit of processing liquid from the tank. Thus, a constant liquid level L is maintained above bar **10** and tubular electrode **31** as shown in FIG. **3**.

These sealing elements **30** will be further discussed in connection with cylindrical bars (FIG. **7**) and non-cylindrical section bars (FIGS. **17–20**).

Upon continuously moving, the bars **10** enter the processing tank **29** through the sealing device **30** on end wall **29'**, and travel a section or length *h* in the tank between the inlet opening and electrode **31**. During this travel, the bar **10** is heated up to the plating temperature, preferably the temperature of the processing liquid, by heat transfer from the liquid. The bar then enters and passes through the perforated tubular electrode **31** where the plating is carried out by deposition of a layer of predetermined thickness, depending on the bar feeding rate and the intensity of the plating current.

The plated bars pass through a corresponding sealing device **30** in exit tank wall **29'** which is fully similar to the above mentioned device. They are then washed with water supplied by a nozzle **34**. The plated bars pass through a second contact box **23'**, which also supplies current, so that plating current is supplied at both ends of tank **29** and the bar temperature is partly retained at the tank outlet to aid in the drying step. Following contact boxes **23'**, the bars (carried by one or more supporting stands **11**) may be further processed as desired.

Downstream of tank **29** and underneath the washing water nozzle **34**, a basin **44** is provided for collecting the washing water and conveying it through a conduit **44'** to a collection tank **45**. Tank **45** is manually identical to tank **40** mentioned above and is provided with a filtering device **41'** and **42**. The water is withdrawn from tank **45** by means of a pump **46** and supplied by a two-way valve **47** either to nozzle **34** or to an external reservoir, according to process requirements.

Similarly, in order to collect any processing liquid lost from tank **29** through sealings **30**, collection basins **30'** are provided upstream and downstream from the tank under the seals. Conduits **30''** collect the lost fluid and convey it to a cooling tank **32** for the processing liquid, the processing tank **29** usually being connected to tank **32** by a loop or closed circuit.

More particularly, plating tank **29** is connected through a gated conduit **35** to tank **32** wherein the liquid is maintained at a predetermined level above a cooling coil **32'** suitably connected to a refrigerating system (not shown). Tank **32** is provided with a thermostat **36** driving the refrigerating system for automatic temperature control and a tap or cock **38** for total discharge. It is also connected by a pipe **37** (partially shown in FIG. **1**) with a tank (not shown) of a higher capacity than that of the processing tank **29** which is connected through suitable pumps and pipes to tank **29** for the recycle of the processing liquid. Thus, processing tank **29** can be continuously supplied with processing liquid of the desired composition and temperature, as the addition of further electrolyte can be directly effected to the above mentioned general or major tank. The use of the cooling coil **32'** for the liquid exiting from processing tank **29** is required since the processing liquid will, in the course of plating operation, be heated and thus have to be cooled prior to recycling for correct control of the processing bath temperature.

The sealing devices **30** on the end walls **29'** of the processing tank may be of any type, e.g., the pneumatic seals more fully described in connection with FIG. **7**. When the sealing devices **30** are of the pneumatic character, the system is provided with a compressed air supply (not shown), this supply being connected through a conduit **48** to the pressure regulator **50** and distributor **49** which, in turn, is connected to several pneumatic sealing devices.

As shown in FIG. **1**, the processing tank **29** is covered with a suction hood **51** and **151** which, as shown also in FIG. **14**, is connected by exhaust fan **153**, conduit **152**, and fume removing device **154** to a stack for conveying the vapors to atmosphere.

As shown in FIG. **14**, conduit **152** has an intermediate section **152'** sloping to the hood for condensate return, as indicated by the broken arrow. Thus, thorough purification of the fumes or vapors from the processing tank can be provided along with recovery of the electrolyte carried by such fumes by water washing. The wash water exits from device **154** through a bottom conduit **155** and can be recycled.

Refering now to FIGS. **5** and **6** of the attached drawings, a different embodiment of the contact box will be described. In the embodiment of FIGS. **5** and **6**, the contact box comprises a hollow cylindrical body **23***a* which has two sealing devices **25'** at the ends thereof, such as those of the pneumatic character hereinafter described, through which bars **10** continuously pass. A chamber **25''** is formed by sealing devices **25'** and cylinder **23***a*, with ingress and egress being provided by

upper aperture 23a', the chamber thus being sealed with respect to the passing of bars 10. A copper strap cathode C is passed through upper aperture 23a' of chamber 25'', takes on the circular shape of the container body, and joins itself outside aperture 23a'. By introducing mercury M (FIG. 6) into the space of chamber 25'', positive electrical contact is provided along the bar circumference for the plating current.

A longitudinal section of a pneumatic sealing sleeve useful at the inlet and outlet openings for the bars in processing tank is shown in FIG. 7. In this Figure, the sealing sleeve substantially comprises a hollow cylindrical body 30, coaxially with cylindrical bars 10, through which the bars to be processed pass. At its ends, hollow cylindrical body 30 has circular openings 56 coaxial with the bar passage. A tubular plastic acid resistant material 57 e.g., an acid resistant rubber, is attached and sealed to openings 56 at its ends and, along with body 30, forms a hermetically sealed annular chamber 58. This chamber 58 communicates with a pressurized air supply through a conduit 59 distributor 49, pressure regulator 50, and conduit 48 (see FIG. 18). Thus, by passing bars 10 through tubular diaphragm 57 in the sealing sleeve 30 and supplying chamber 58 with air pressure, diaphragm 57 is urged toward the surface of bar 10 and provides a positive sealing for the processing liquid in tank 29. Moreover, while providing for a seal on bar 10, diaphragm 57 will not inhibit the sliding thereof. The use of a pneumatic sealing sleeve also allows for the accommodation of bars of different diameters without the replacement thereof. However, it is apparent that for bars of substantially different diameters, sealing sleeves of different sizes should be employed.

Sealing device 30, and more particularly the above mentioned sealing sleeve, can be fixedly attached to end walls 29' of the processing tank when the latter is to be used for electroplating the same type of bars at all times, or can be detachably and readily, replaceably secured (as shown in FIG. 8) when the material to be plated varies. As shown in this Figure, sealing device 30 can be carried by a plate 60 and positioned within a channel or U-shaped seating 61' formed along the edge of a saddle-like notch 61 provided on each wall 29' of the processing tank 29 when in use. Thus, one tank can be used for processing bars having different cross-sectional shapes and sizes.

However, the sealing device 30 can also be of the plate type, as described below in connection with a modified form of the invention. Of course, along the edge 60 of tank 29 provision should be made for a suitable seal for the liquid in the tank.

Referring now to FIGS. 11, 12 and 13 of the attached drawings, an exemplary structure for the cleaning device 26 will be described.

As shown, this device comprises two yoke-shaped elements 62 of substantially symmetrical construction, each having a semicircular notch containing an abrasive felt 27 or other appropriate material. The two yoke-shaped elements 62 are attached to each other by any suitable clamping device, for example, resilient binding 63 shown in FIG. 13. Upper yoke-like element 62 is also provided with a conduit 28 for admission of wash water, as above set forth. A bracket 64 partially surrounds upper yoke-like element 62 and is provided with an arm 65 which is connected to the stem 66 of a pneumatic or oleodynamic type of double-acting cylinder 67. Movement of the piston by fluid pressure from a source which is not shown provides reciprocating rotation for effective operation of the cleaning device. If desired, cleaning device 26 could be continuously rotated rather than alternatively rotated.

Referring now to FIGS. 15 and 16, a schematic modified form of the system according to the invention will be described. In these Figures, all of the devices or parts common to FIG. 1 have not been shown for the sake of simplicity. As shown, the processing tank 116 has been herein placed with a second tank 117 of a larger size in order to allow for electroplating tubes, circular cross-section bars and non-circular cross-section bars. Thus, a particular plate sealing device has been designed for the latter.

The bottom 116' of processing tank 116 is elevated from the bottom 117' of the outer tank and is supported by legs 118. Outer tank 117 is of a higher capacity than the inner tank 116 and the liquid in tank 117 is maintained at a level L' below the bar passage openings in its walls, while inner tank 116 is completely filled with the processing liquid. The processing liquid is maintained at a predetermined temperature by heating elements 119 and is continuously recycled by means of pumps 120 and 120' so that the liquid level in tank 116 is substantially constant and above the bars 110 which are to be processed.

In order to reduce heat loss in the processing liquid in outer tank 117, covering baffles 121 are provided between adjacent walls of the tanks. The baffles are located below openings 123 through the inner tank and are retained spaced apart from the inner tank adjacent the openings to allow the passage into the bottom of tank 117 of the processing liquid which leaks from the sealing devices 126 and overflows from the top edge of the inner tank. To this end, the upper edges 116'' of inner tank 16 adjacent the seals are relatively lower than the rest of the tank edges, so that the liquid exhaust and overflow will occur in this zone.

Of course, openings 122 and 123 in the two tanks should be aligned with one another along a common axis for the bar or section electroplating operation. A tubular anode 131 is located within inner tank 116 and completely immersed in the processing solution.

The double tank can be used for electroplating bar stock where a pneumatic sleeve sealing of the above described character could not be used. However, it is apparent that instead of the double tank system, the system as shown in FIG. 1 could be used, providing end tanks 30' of higher capacity than shown for collecting the processing liquid.

In FIGS. 17–20, a further embodiment for sealing processing tank 29 or 116 when plating various cross-section bars is shown. As shown in the Figures, bar 138 is surrounded throughout its profile by a double row of flexible blades 139. The blades of each row are located at equal short spacings from one another and staggered relative to the blades in the adjoining row, so that one blade 139 in a row will bridge the spacing between two adjoining blades 139 in the other row. Thus, the whole openings 123 is obstructed by the double rows of blades interferring with the exit of the processing liquid from inner tank 116, and thus allowing the maintenance of substantially constant liquid level in the tank, since the tank is continuously supplied with an amount of liquid equal to the amount of liquid existing laterally and at the bottom of the bars. Blades 139 are secured to edge 123' of opening 123 on three sides, while at the

top of the tank, the blades **139** are secured to lower edge **140'** of a gate or sliding plate **140.** The plate is slipped into and positioned by grooves **124'** (FIG. **17**). By moving plate **140,** the position of blades **139** can be controlled, and thus the closure of opening **123** can be regulated to control liquid exit. Plate **140** is provided with means to fix its position (not shown) as desired, for example, by clamping screws or other equivalent means. Further, as shown in FIG. **19,** at the lower edge of opening **123** the blades will intersect one another and further inhibit liquid loss.

Opening **123** could also have the lower portion, as well as the blades on plate **140,** in the form of oppositely corresponding arcs so as to direct said blades **139** to the geometrical axis of the bars **138** to be processed. Of course, blades **139** of FIGS. **17–20** should be made of an acid resisting, relatively resilient and flexible material in order not to be attacked by the processing liquid in the tank and to maximize liquid retention.

Referring to FIG. **1,** the operation of the apparatus according to the invention is substantially as follows:

Bars **10** are successively mechanically and/or electrically interconnected and carried by stands **11.** They are fed to processing tank **29** after first passing through the contact box **23,** then through cleaning device **26,** and finally through seal **30** in tank **29.** In the tank, the bars are immersed in the processing liquid contained in anode **31** and are coated by electroplating. The coated bars emerge from end wall **29'** of the tank, through seal **30** and are washed, dried and then further processed as desired.

As mentioned above, in the course of the first travel path of each bar between contact box **23** upstream of tank seal **30,** a first preheating of the bar is effected at a lower temperature than the electroplating temperature by the flow of the electroplating current through the bar. Also, in the length or section *h* within the tank between end wall **29'** and the tubular anode **31** adjacent thereto, a second heating step for bars **10** is effected so that the bar temperature is substantially the same as that of the processing liquid in the electroplating bath. By way of example, a length or distance *h* of about 50cm (20 inches), depending on the feed rate of the bar, usually provides for proper heating of the bar. The plating bath temperature may vary in accord with known ranges.

Thus, a process for operating under optimum working conditions is disclosed herein, in which a continuous electroplating system functions with high hourly output and produces coatings which are within strict tolerances along each bar and between different bars. Moreover, the particular system herein described allows for the maintenance of a substantially constant temperature in the bath and has the advantage of avoiding any pollution because of the liquid recirculation and/or the purification of the fumes or vapors from the processing bath.

What is claimed:

1. A method for continuously electroplating a plurality of elongated bars in a plating comprising:

a. mechanically attaching said bars together by couplings of the same section as said bars to provide a generally continuous electroplatable surface;

b. serially cleaning said attached bars prior to plating by passing said bars consecutively through a cleaning medium;

c. serially passing said bars into contact with an electrode whereby said bars are charged with an electroplating current;

d. serially heating said bars to the temperature of said bath prior to plating;

e. serially passing said bars through said electroplating bath and in the proximity of an electrode whereby said bars are electroplated; and

f. serially passing the plated bars out of said bath.

2. The method of claim **1** wherein said preheating is effected by first preheating said bars outside said bath and by secondly preheating said bars in said bath prior to the plating step.

3. The method of claim **2** wherein said first preheating is effected by said electroplating current.

4. The method of claim **3** wherein said second preheating is effected by the contact of said bath with said bar prior to electroplating.

5. The method of claim **3** wherein said mechanical connection is additionally an electrical connection.

6. The method of claim **1** wherein said electrode in said bath is a tubular electrode positioned co-axially with said bars.

7. The method of claim **1** wherein said bars are additionally cleaned after passage out of said bath.

8. The method of claim **7** wherein said cleaning after plating includes washing.

9. An apparatus for continuously electroplating a plurality of elongated bars comprising:

a. means for serially mechanically attaching said bars together;

b. aligning means positioning said attached bars along an axis;

c. cleaning means prior to electroplating for cleaning said aligned bars;

d. drive means causing said bars to traverse the line of said axis;

e. a plating tank containing plating liquid and having seal means on two ends thereof positioned coaxially with the axis of said bars whereby said bars pass serially into said tank through first seal means, through said tank and out of said tank through said seal means;

f. heating means for said bars for heating said bars prior to electroplating in said tank to the temperature of said plating liquid prior to electroplating;

g. a first electrode positioned outside said tank and a second elongated electrode positioned inside said tank whereby said electrodes cooperate to provide an electroplating current to plate said bar with material in said plating liquid, said electrodes being positioned coaxially with said bar, and said first electrode being in electrical contact with said bar before said bar enters said tank while said second electrode is spaced from said bar.

10. The apparatus of claim **9** wherein said heating means includes the current passed along said bars by said electrodes.

11. The apparatus of claim **9** further including second cleaning means for cleaning said plated bars.

12. The apparatus of claim **9** further including recycle means for recycling lost plating liquid to said plating tank.

13. The apparatus of claim **9** wherein said drive means includes upper and lower rollers in contact with said bars, means for adjustably positioning said rollers, and means driving at least one of said rollers.

14. The apparatus of claim 13 wherein said rollers have a resilient surface with a circumferential groove therein.

15. The apparatus of claim 12 wherein said recycle means further includes a reservoir pump means and plating liquid cooling means in said reservoir.

16. The apparatus of claim 9 further including a third electrode downstream of said second electrode and of opposite polarity than said second electrode.

17. The apparatus of claim 9 wherein said second electrode is spaced from first seal means in said tank.

18. The apparatus of claim 9 wherein said tank is closed at its top by a hood connected to a fume removing means.

19. The apparatus of claim 12 wherein said recycle means includes a second tank of greater capacity than said plating tank and pump means for effecting said recycling, said plating tanks being arranged in said second tank so that fluid lost from said plating tank is retained by said second tank.

20. The apparatus of claim 9 wherein said first electrode comprises a copper electrode arranged around said bars and held in electrical contact therewith by clamping means peripherally of said bars.

21. The apparatus of claim 9 wherein said first electrode includes a hollow cylindrical body arranged coaxially with said bars and having seal means at the ends thereof, said seal means and said body forming a chamber, said chamber containing mercury and having a charged electrical connection in contact therewith whereby said connection and said mercury cooperate to charge said bars.

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